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Indian Standard

SPECIFICATION FOR GENERAL PURPOSE PUSH-PULL SINGLE-POLE CIRCUIT-BREAKERS FOR AIRCRAFT

UDC 621·316·57 : 629·13·066 : 620·16

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

[redacted] Gr 5

April 1979

Indian Standard

SPECIFICATION FOR GENERAL PURPOSE PUSH-PULL SINGLE-POLE CIRCUIT-BREAKERS FOR AIRCRAFT

Aircraft Electrical Equipment Sectional Committee, ETDC 55

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Indian Standard

SPECIFICATION FOR GENERAL PURPOSE PUSH-PULL SINGLE-POLE CIRCUIT-BREAKERS FOR AIRCRAFT

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 October 1978, after the draft finalized by the Aircraft Electrical Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard is based on ISO/R1467, 'Performance requirements for general purpose push-pull single-pole circuit-breakers for aircraft', issued by the International Organization for Standardization.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies the performance requirements for push-pull single-pole, trip-free circuit-breakers having an inverse time/current characteristic of normal ratings up to and including 35 A for use in nominal 28 V dc or 115 V ac single-phase 400 Hz line-to-neutral circuits or suitable for both ac and dc circuits.

Note — If the circuit-breaker is required for use for 200 V ac line-to-line circuits, tests outside the scope of this standard may be necessary.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

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*Rules for rounding off numerical values (*revised*).

2.1 Push-Pull Circuit-Breaker — A circuit-breaker with a single button to trip and reset the breaker, by pushing to make and pulling to break.

2.2 Trip-Free Circuit-Breaker — A circuit-breaker so designed that holding the push-button in the closed position will not over-ride the tripping mechanism and will not permit subsequent closure of the contacts, until the push-button has been returned to the open position and the tripping mechanism has reset.

2.3 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general qualities and design of a given type of circuit-breakers.

2.4 Acceptance Tests — Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

2.5 Routine Tests — Tests carried out on each item to check the essential requirements which are likely to vary during production.

3. RATINGS

3.1 Voltage — The circuit-breaker shall be suitable for operation in a nominal 28 V dc or 115 V ac, single phase, 400 Hz supply or for both of these ac and dc supplies.

3.2 Current — The preferred normal current rating of the circuit-breaker shall be chosen from 1, 2, 3, 5, 7·5, 10, 15, 20, 25 or 35A.

4. CONSTRUCTION

4.1 The push-button shall be insulated from all current carrying parts, and shall not remain in an intermediate position or give a false indication.

4.2 The circuit-breaker shall be operated by a single button, pushed to make and pulled to break the circuit, the button being perpendicular to the plane of the mounting panel. The portion of the button visible when the circuit-breaker is in the closed position shall be black. A white band on the button shall be exposed when the circuit-breaker is in the open position.

4.3 The portion of the circuit-breaker visible when mounted shall have a non-glaring finish.

4.4 The circuit-breaker shall be so constructed that tampering with the calibration is not possible without dismantling the device or breaking a seal.

4.5 Each terminal screw or stud shall be of size M4 × 0·7 and shall be capable of accepting two tag-type terminations.

4.6 The circuit-breaker shall be mounted by means of a threaded bush suitable for use with the panel mounting hole specified in IS : 8852-1978*. Two hexagonal mounting nuts, one locating washer and one internal shake-proof washer shall be provided with each circuit-breaker.

4.7 The circuit-breaker shall be suitable for through panel mounting preferably by single-hole fixing and shall operate satisfactorily when mounted in any attitude.

4.8 The circuit-breaker shall be trip-free and shall incorporate an overcurrent tripping device.

4.9 The circuit-breaker shall be so designed that after tripping on overload, it cannot re-close automatically.

5. REQUIREMENTS

5.1 The circuit-breaker shall be suitable for use at ambient temperatures from −40 to +71°C and at altitude up to 18 300 m.

5.2 The circuit-breaker shall be so constructed that the forces required to operate it manually do not exceed the following values:

Closing force	55N
Tripping force	40N

NOTE — It is envisaged that in any particular design of circuit-breaker, the actual value will be controlled to close limits.

5.3 The envelope and fixing dimensions for the circuit-breaker shall comply with IS : 8852-1978*.

5.4 Environment — The circuit-breaker shall comply with the requirements of vibration, acceleration, crash-landing, climatic, explosion-proofness and magnetic influence in accordance with the relevant Indian Standards where available. They shall not support mould growth and shall not deteriorate even after storage for long periods in the tropics.

NOTE — Till such time Indian Standards on environmental tests for aircraft equipment are made available the requirements and methods of tests for the above tests shall be subject to agreement between the manufacturer and the purchaser.

5.5 Time/Current Characteristics — The time/current characteristics of each circuit-breaker shall be within the limits shown in Table 1, which represents envelope characteristics to cover all manufacture.

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*Dimensions for general purpose push-pull single-pole circuit-breakers for aircraft.

TABLE 1 LIMITS FOR TIME/CURRENT CHARACTERISTICS

(*Clauses* 5.5, 6.1, 8.5, 8.6.1, 8.7, 8.13.4, 8.14.1, 8.15.3, 8.16.4, 8.17.4 *and* 8.23.3)

CIRCUIT-BREAKER NORMAL CURRENT RATING (PER LINE) (1) A	AMBIENT TEMPERATURE (2) °C	TRIPPING CURRENT AS PERCENTAGE OF NORMAL CURRENT (3)	TRIPPING TIME (4) s
1 to 35	27 ± 2	200	12 to 60
		400	2 to 7·5
		600	1 to 3·5
		1 000	0·35 to 1·2
1 to 5	−40 ± 3	200	70 to 350
		400	5 to 15
		600	2 to 6
		1 000	0·7 to 2
7·5 to 35	−40 ± 3	200	27 to 200
		400	3·5 to 12
		600	1·5 to 5
		1 000	0·5 to 1·75
1 to 35	71 ± 3	200	8 to 45
		400	0·8 to 7
		600	0·6 to 3
		1 000	0·2 to 1

5.6 Making and Breaking Capacity — The circuit-breaker shall have a making and breaking capacity appropriate to the relevant categories shown in Tables 2 and 3, when tested under the conditions described in **8.17**.

TABLE 2 MAKING AND BREAKING CAPACITY FOR dc CATEGORIES

(*Clauses* 5.6, 6.1, 8.17.1 *and* 8.17.2)

RUPTURING CAPACITY CATEGORY	CALIBRATED TEST CURRENT (PROSPECTIVE CURRENT)			
	A	A	A	A
(1)	(2)	(3)	(4)	(5)
1·5	—	—	1 500	1 000
3	—	3 000	1 500	1 000
6	6 000	3 000	1 500	1 000

TABLE 3 MAKING AND BREAKING CAPACITY FOR ac CATEGORIES

(*Clauses* 5.6, 6.1, 8.17.1 *and* 8.17.3)

RUPTURING CAPACITY CATEGORY	CALIBRATED TEST CURRENT (PROSPECTIVE CURRENT)			
	A	A	A	A
(1)	(2)	(3)	(4)	(5)
1	—	—	1 000*	750†
2	—	—	1 000†	750†
3·5	3 500*	2 000†	1 000†	750†

*At 0·4 to 0·5 lagging power factor.
†At unity power factor.

5.7 Endurance — The circuit-breaker, when carrying current, shall be capable of withstanding 10 000 cycles of manual close and open operations at the fastest practicable rate, but not less than two complete cycles per minute with approximately equal periods of closure and opening under the conditions described in **8.16**.

5.8 At the values of current specified in **5.5**, the circuit-breaker contacts shall open automatically within the time limits stated and the manual operating device shall move to the open or off position.

6. DECLARATIONS

6.1 The declarations made by the manufacturer in accordance with IS : 7855-1975* should include:

a) the category of the circuit-breaker in relation to its making and breaking capacity (*see* Tables 2 and 3);

b) the envelope of the time/current characteristics for each rating of circuit-breaker at each temperature given in Table 1;

c) for circuit-breakers of 1 to 10A capacity, the tripping times for 20 and 30 times normal current;

d) the maximum current which the circuit-breaker will carry for 1 hour at a temperature of 71°C without tripping;

e) the maximum and minimum forces necessary to operate the circuit-breaker manually; and

f) the system of batching used for quality test sampling.

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*Form of declaration of performance of aircraft electrical equipment.

7. MARKING

7.1 The following information shall be clearly and indelibly marked on each circuit-breaker:

a) Number of this Indian Standard, that is, ISS : 8980;
b) Manufacturer's name or identification;
c) Manufacturer's type number; and
d) Current and voltage ratings.

7.2 The normal current rating of the circuit-breaker shall be indelibly marked on the end of the push-button.

7.2.1 The circuit-breaker may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

8. TESTS

8.0 The tests shall be carried out with the cover on. With the exception of the making and breaking capacity tests for which the test circuit is prescribed, all tests shall be performed with the circuit-breaker connected on each side by a copper-cored cable of appropriate size. Each cable shall be at least 1 m in length and shall be attached to the circuit-breaker by a crimped termination of approved design.

8.1 Type Tests — The following shall constitute the type tests:

a) Dimensional check (**8.4**),
b) Vibration test (**8.5**),
c) Acceleration test (**8.6**),
d) Climatic test (**8.7**),
e) High voltage and insulation tests (**8.8**),
f) Explosion-proofness (**8.9**),
g) Magnetic influence (**8.10**),
h) Temperature rise and minimum and maximum limits of ultimate trip current (**8.11**),

j) Operating forces test (**8.12**),
k) Mechanical strength tests (**8.13**),
m) Calibration of overload trip (**8.14**),
n) Overload and reclosure test (**8.15**),
p) Endurance tests (**8.16**),
q) Making and breaking capacity tests (**8.17**),
r) Self reclosing at low temperature (**8.18**), and
s) Calibration tests (**8.23**).

8.1.1 The tests shall be made on representative samples of each particular design and rating of circuit-breaker unless agreement has been obtained to the omission of specific tests on intermediate ratings.

8.1.2 With the exception that a separate circuit-breaker may be used for the fungus growth test, the tests given in **8.5**, **8.6.1** and **8.7** shall be performed on the same circuit-breaker in the stated order. The tests in **8.6.2** and **8.9** to **8.18** may be performed on another circuit-breaker or other circuit-breakers except that the tests in **8.12** and **8.16.2** or **8.16.3** shall be made on one circuit-breaker. At the end of the test or group of type tests, to which each circuit-breaker is subjected, it shall be tested in accordance with **8.8.2** and shall then be stripped and examined in accordance with **8.22**.

8.2 Acceptance Tests — The following shall constitute the acceptance tests:

a) Dimensional check (**8.4**),
b) Operating force test (**8.12**),
c) Minimum and maximum limit of ultimate trip current (**8.19**),
d) Calibration of overload trip (**8.20**),
e) Vibration test (**8.21**), and
f) Strip examination and report (**8.22**).

8.2.1 A recommended sampling scheme is given in Appendix A.

8.3 Routine Tests — The following shall constitute the routine tests:

a) High voltage and insulation tests (**8.8**), and
b) Calibration tests (**8.23**).

8.4 Dimensional Check — The circuit-breaker shall conform to the requirements of **5.3**.

8.5 Vibration Test — The circuit-breaker shall be subjected to the appropriate vibration tests described in the relevant Indian Standard (*see also* Note below **5.4**).

The resonance tests shall be conducted with the circuit-breaker in both the open and closed positions with normal rated voltage or current applied, as appropriate and in each case oscilloscopic methods shall be used, to check that there is no inadvertent opening or closing of the contacts throughout the test. Ten percent of the vibration endurance tests (fatigue tests) shall be performed with the circuit-breaker in the open position and 90 percent with the circuit-breaker in the closed position and carrying 100 percent normal rated current. At intervals of not greater than 3 h during the latter test the voltage drop across the circuit-breaker terminals shall be measured and shall not exceed the limits shown in Table 4.

At the end of the test a cooling period of not less than 2 h shall be allowed followed by a calibration check at 200 percent rated current. Tripping shall occur within the time limit shown in Table 1 for 27°C.

TABLE 4 VOLTAGE DROP AND INDUCTANCE OF LOAD

(*Clauses* 8.5, 8.7, 8.16.2 *and* 8.16.4)

NORMAL RATED CURRENT (1) A	VOLTAGE DROP ACROSS TERMINALS (2) mV *Max*	INDUCTANCE OF LOAD FOR dc TESTS (3) H
1	1 500	1·0
2	1 000	0·5
3	750	0·4
5	300	0·2
7·5	300	0·15
10	300	0·1
15	225	0·07
20	200	0·05
25	200	0·04
35	160	0·03

8.6 Acceleration Test

8.6.1 The circuit-breaker shall be subjected to the appropriate acceleration tests described in the relevant Indian Standard (*see also* Note below **5.4**) for a period of not less than 1 min with the circuit-breaker in both the open and closed positions with normal rated voltage or current applied, as appropriate. A check shall be made to ensure that there is no inadvertent opening or closing of the contacts throughout the tests.

At the end of the test a cooling period of 2 h in free air shall be allowed, followed by a calibration check at 200 percent normal rated current. Tripping shall occur within the time limits shown in Table 1 for 27°C.

8.6.2 The circuit-breaker shall be subjected to the appropriate crash-tests both in the closed position and carrying normal rated current, and in the open position. It shall remain closed or open as appropriate during this test.

8.7 Climatic Test — The circuit-breaker shall be subjected to the appropriate climatic tests.

Functioning tests as described in (a), (b) and (c) below shall be made in accordance with the requirements of the relevant Indian Standards (*see also* Note below **5.4**) during the course of climatic testing. At the conclusion of the tropical exposure and fungus growth tests, tests (a), (b) and (c) shall be made:

a) A calibration check at 200 percent rated current. Tripping shall occur within the time limits shown in Table 1 appropriate to the particular ambient temperature.

b) Ten make and break operations performed over a period of 1 minute at rated voltage and 100 percent rated current or declared current when the test is made at 71°C, with a resistive load. The voltage drop across the circuit-breaker terminals shall be measured carrying 100 percent rated current and shall not exceed the limits shown in Table 4.

c) The circuit-breaker shall carry the declared current in ambient temperature of 71°C for 1 hour without tripping.

8.8 High Voltage and Insulation Tests — The circuit-breaker shall be subjected to tests in accordance with **8.8.1** and **8.8.2**.

8.8.1 *High Voltage Test* — A test voltage of not less than 1 400 V rms at 50 or 60 Hz or eight times rated operating voltage, whichever is greater, shall be applied for a period of 5 to 10 s between:

a) the terminals with the circuit-breaker in the open position;

b) the terminals connected together and the metallic mounting plate to which the circuit breaker is fastened by its normal mounting arrangement, with circuit-breaker in the open and closed position;

c) the terminals connected together and all exposed metal parts; and

d) the tip of the actuating device(s) and the terminals connected together with the circuit-breaker in the open and closed position.

The voltage shall be increased gradually.

8.8.2 *Insulation Resistance Test* — Immediately following the tests described in **8.8.1**, the insulation resistance shall be measured at a potential of 500 V dc between the same points as in **8.8.1** (a) to (d) and the results shall comply with the relevant Indian Standard.

8.9 Test for Explosion-Proofness — The circuit-breaker shall be subjected to the test described in the relevant Indian Standard for explosion-proof equipment (*see also* Note below **5.4**).

8.10 Measurement of Magnetic Influence — The compass safe distance relative to the circuit-breaker when carrying 100 percent rated current shall be measured in the manner described in IS : 8252(Part XVIII)-1978*

8.11 Tests of Temperature Rise and Minimum and Maximum Limit of Ultimate Trip Current

8.11.1 The circuit-breaker, in conditions of still air shall be submitted to the tests detailed in Table 5. Immediately on completion of the final test, with the circuit-breaker still hot in an ambient temperature of 71°C, the circuit-breaker shall be subjected to a test in accordance with **8.8.2**.

The temperature-rise in the attached cable (measured with a suitable thermocouple when the temperature reading becomes stable, at the surface of the conductor beneath the insulation at a point 25 mm from the end of the insulation) shall not exceed 55°C.

TABLE 5 TRIPPING CURRENTS AND TRIPPING TIMES

(*Clause* 8.11.1)

AMBIENT TEMPERATURE (1)	TRIPPING CURRENT (2)	TRIPPING TIME (3)
°C	% Normal Current	h
27 ± 2	115	1 (*see* Note)
27 ± 2	140	⩽ 1
—40 ± 3	140	> 1
−40 ± 3	180	⩽ 1
71 ± 3	100	> 1
71 ± 3	130	⩽ 1

NOTE — For this test the temperature-rise of external parts shall be measured and shall not exceed the figures quoted in **8.11.2** and **8.11.3**.

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*Environmental tests for aircraft equipment : Part XVIII Magnetic influence.

8.11.2 The temperature of any component or part of the circuit-breaker which may normally be accessible to, or inadvertently touched by occupants of the aircraft under operating conditions shall not exceed 100°C at maximum ambient temperature.

8.11.3 The temperature-rise of any part which is necessarily handled and which is made from or covered with, material which is a poor thermal conductor, shall not exceed 20°C. If such a part is made from metal the temperature rise shall not exceed 10°C.

8.12 Operating Forces Test — The maximum and minimum forces necessary for the operation of the circuit-breaker for both the open and closed positions shall be determined and declared. The force shall be applied in the line of travel of the push-button. The force required to operate the circuit-breaker shall not exceed the values specified in **5.2**.

During this test it shall be established that the circuit-breaker has a positive action and shall not remain with the botton in an intermediate position when operating to the open and closed positions. It shall also be established that the point of maximum pressure occurs before the contacts close or open, and that the pressure decreases rapidly thereafter.

8.13 Mechanical Strength Tests

8.13.1 *Strength of Terminations* — All terminations shall be subjected for not less than 1 minute to:

a) a 45 N pull in each of the following directions:
  1) parallel to the long axis of the terminal screw;
  2) at right angles to the long axis of the terminal screw;

b) a torque of 1·8 N-m applied to the terminal screw.

8.13.2 *Strength of Push-Button* — A force of 90 N shall be applied to the push-button for not less than 1 minute under each of the following conditions, during which the circuit-breaker shall be connected electrically to check contact operation:

a) Perpendicular to the axis of travel of the push-button in both the direction along the major and minor axes of the body of the circuit-breaker in both the open and closed positions.

b) Co-axial with the push-button axis towards and away from the circuit-breaker body throughout the entire range of push-button travel.

For the test in (a) above the load shall be applied 3 mm from the end of the push-button.

8.13.3 *Strength of Panel Mounting Bush*—A tightening torque of 3·6 N-m shall be applied for not less than 1 min to the mounting nut with the circuit-breaker mounted in a panel and located by means of the locating washer and keyway.

8.13.4 There shall be no damage or distortion to the threads, keyway locating washer, locknut or circuit-breaker as a result of the tests described in **8.13.1**, **8.13.2** and **8.13.3** immediately following which the circuit-breaker shall:

a) satisfy the requirements of the insulation resistance test (**8.8.2**);

b) carry 100 percent normal rated current in a temperature of 27 ± 2°C for 1 h without tripping; and

c) trip within the time limits shown in Table 1 for 27°C when carrying 200 percent normal rated current.

8.14 Test of Calibration of Overload Trip

8.14.1 The circuit-breaker shall be subjected to a series of tripping tests in ambient temperatures of 27 ± 2°C, —40 ± 3°C and 71 ± 3°C, to confirm its compliance with the performance requirements given in Table 1.

8.14.2 In addition, to determine this characteristic completely, tripping times shall be recorded and declared for currents of 20 and 30 times normal current on circuit-breakers rated 3 to 10 A. Each tripping time shall be measured at least three times, a cooling period of not less than 2 hours being allowed between checks.

8.15 Overload and Reclosure Test

8.15.1 The circuit-breaker shall be connected to control a resistive load carrying 200 percent normal rated current, and shall be operated as follows:

> Close-trip automatically-reclose within 20 seconds of automatic trip. These operations shall be repeated 50 times.

8.15.2 Immediately following reclosing of the circuit-breaker at the end of the last operation in **8.15.1** the load shall be reduced to 115 percent of normal rated current and shall be carried for a period of 1 hour without automatic tripping.

The voltage drop across the circuit-breaker terminals shall be measured at the end of this test carrying 100 percent rated current and shall not exceed the limits specified in **8.16**.

8.15.3 At the end of the tests described in **8.15.1** and **8.15.2** a cooling period of not less than 2 h. shall be allowed, followed by calibration checks on the same circuit-breaker at 200 percent, 400 percent, and 600 percent normal rated current. Tripping shall occur within the time limits specified in Table 1.

8.16 Endurance Tests

8.16.1 A single circuit-breaker shall be checked for compliance with the requirements for the limits of ultimate trip (**8.11**) and the operating forces test (**8.12**) and shall be subjected to 10000 cycles of manual close and open operations at the fastest practicable rate, but not less than two complete cycles per minute, divided as stated in **8.16.2** or **8.16.3**. If the circuit-breaker has both an ac and dc rating, separate samples may be used for these tests. The time closed shall be approximately equal to the time open.

The manual operation may be performed mechanically but shall simulate normal correct manual operation of the circuit-breaker, including overtravel where this is a feature of the design.

No adjustment to the mechanism or contacts shall be made at any time during the tests.

8.16.2 *DC Test Conditions*:

a) 2 400 cycles at 100 percent normal rated current resistive load at sea level;

b) 2 500 cycles at 1 A, 0·6 H inductive load at sea level;

c) 2 500 cycles at 100 percent normal rated current resistive load at a pressure corresponding to 18 300 m altitude;

d) 2 500 cycles at 1 A, 0·6 H inductive load at a pressure corresponding to 18 300 m altitude;

e) 50 cycles at 100 percent normal rated current, with an inductive load as shown in Table 4, at sea level; and

f) 50 cycles at 100 percent normal rated current, with an inductive load as shown in Table 4, at a pressure corresponding to 18 300 m altitude.

The test voltage shall be maintained at 28^{+2}_{-0} V dc, throughout.

8.16.3 *AC Test Conditions*:

a) 2 500 cycles at 100 percent normal rated current resistive load at sea level;

b) 2 500 cycles at 100 percent normal rated current in a circuit of 0·75 power factor lagging at sea level;

c) 2 500 cycles at 100 percent normal rated current resistive load at a pressure corresponding to 18 300 m altitude; and

d) 2 500 cycles at 100 percent normal rated current in a circuit of 0·75 power factor lagging at a pressure corresponding to 18 300 m altitude.

The test supply shall be maintained at $115 \, ^{+10}_{-0}$ V ac, 380 to 420 Hz throughout.

8.16.4 During the tests described in **8.16.2** or **8.16.3** the voltage drop across the circuit-breaker terminals shall be measured at 100 percent normal rated direct current, prior to commencement of the test, at every 500 cycles of operation and on completion of the test, and shall at no time exceed the limits shown in Table 4.

At the conclusion of the endurance test, the circuit-breaker shall be subjected to a check calibration of minimum and maximum limits of ultimate trip current as in **8.11**. The tripping time shall also be checked at 200 percent rated current and shall be within the limits shown in Table 1 for 27°C.

8.16.5 Upon completion of the tests described in **8.16.1** to **8.16.4** the circuit-breaker shall be retested in accordance with **8.12.**

8.17 Making and Breaking Capacity Tests

8.17.1 Tests shall be performed at the prospective test current stated in Tables 2 or 3 appropriate to the declared rupturing capacity of the circuit-breaker under test.

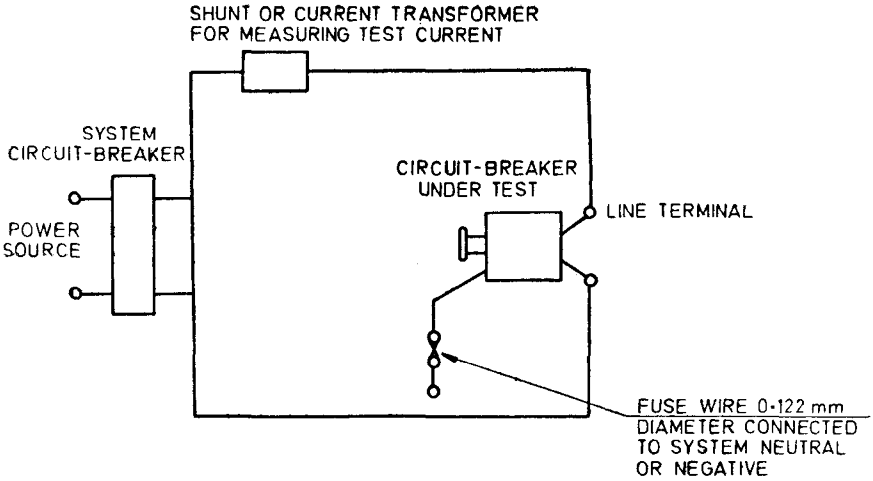
More than one circuit-breaker may be used for these tests but tests at a particular test current and air pressure shall be made on the same sample.

The circuit-breaker shall be tested at an air pressure corresponding to sea level and at an air pressure corresponding to an altitude of 18 300 m by inserting it into the calibrated test circuit and testing as follows:

Break test current — make and break test current — make and break test current.

NOTE — Sufficient force shall be applied to the operating button to achieve normal closing of the circuit-breaker: a suggested normal rate of travel of the button is 12·7 mm/s.

During the calibration tests the cable terminals normally connected to the circuit-breaker under test shall be clamped together without an intermediate link. A fine fuse wire (0·122 mm diameter) shall be connected between the circuit-breaker mounting face and the system neutral or negative. A typical test circuit is shown in Fig. 1.


SHUNT OR CURRENT TRANSFORMER FOR MEASURING TEST CURRENT
SYSTEM CIRCUIT-BREAKER
POWER SOURCE
CIRCUIT-BREAKER UNDER TEST
LINE TERMINAL
FUSE WIRE 0·122 mm DIAMETER CONNECTED TO SYSTEM NEUTRAL OR NEGATIVE

NOTE — All connections shall be as short as possible and of very low resistance. The system circuit-breaker shall be capable of making and breaking repeatedly and without deterioration the maximum specified test current.

FIG. 1 TYPICAL TEST CIRCUIT FOR BREAKING CAPACITY TEST

The actual time of rise of the test current shall be recorded during the calibration tests and this value shall be stated in the test reports.

Oscillograph records of the test current during these tests shall be made.

This open-circuit voltage shall be maintained across the circuit-breaker terminals for a minimum period of 5 s after recovery to stable conditions, and there shall be no current flow or arcing between the contacts during this period.

During the test there shall be no leakage current as indicated by melting of the fine fuse wire.

8.17.2 *DC Test Conditions* — A source of power capable of providing current of the values specified in Table 2 shall be calibrated to conform with the following requirements:

a) the open circuit voltage shall be 28 $^{+4}_{-0}$ V dc;

b) the transient open-circuit recovery voltage after interruption of the test current shall be as follows:

   i) recovery to 28 V to occur within 0·002 s;

  ii) maximum voltage not to exceed 50 V;
  iii) subsequent excursion above or below the nominal voltage to constitue a damped oscillation;

c) the relevant prospective current shall be reached as follows:

  i) currents up to 3 000 A in not more than 0·005 s;
  ii) current of 6 000 A in 0·010 to 0·030 s.

8.17.3 *AC Test Conditions* — A source of power capable of providing current of the values specified in Table 3 shall be calibrated to conform with the following requirements:

a) the open circuit voltage shall be 115 $^{+10}_{-0}$ V rms at 400 ± 20 Hz;
b) the transient open circuit recovery voltage after interruption of the test current shall be 120 V within three cycles, 150 V within six cycles, and shall not exceed 165 V;
c) the relevant prospective current shall be reached between 10 and 25 cycles; and
d) the frequency during the test shall be between 350 and 450 Hz.

8.17.4 At the conclusion of the tests described in **8.17.2** or **8.17.3** and after a cooling period of not less than 1 hour, each circuit-breaker shall have a tripping time within 120 percent of the maximum and 80 percent of the minimum times specified in Table 1. The high voltage and insulation resistance tests specified in **8.8** shall then be repeated.

8.18 Test of Self Reclosing at Low Temperature — The circuit-breaker shall be tripped automatically under overload conditions in an ambient temperature of —50 ± 3°C and shall be kept at this temperature for 1 hour during which it shall not reclose automatically.

8.19 Tests of Minimum and Maximum Limit of Ultimate Trip Current — Each sample circuit-breaker shall be subjected to the tests described in **8.11** without measurement of temperature rise.

8.20 Test of Calibration of Overload Trip — Each sample-circuit-breaker shall be subjected to the tests described in **8.14** at 27 ± 2°C only.

8.21 Vibration Test (for Acceptance) — One sample circuit-breaker of each rating in the batch, unless of the prior agreement of the approving authority has been obtained to the omission of intermediate ratings, shall be subjected to vibration endurance tests in accordance with **8.5** followed by 10 hours tests at each of any resonant frequencies detected during type approval tests.

8.22 Strip Examination and Report — Upon completion of acceptance tests, each sample circuit-breaker shall be opened and examined for any signs of deterioration. A report on the condition of each circuit-breaker shall be submitted to the Inspecting Authority.

8.23 Calibration Tests

8.23.1 The manufacturer may use methods best suited to his need for setting the calibration of circuit-breakers. The test equipment may include connections suitable for the quick handling of circuit-breakers. It shall be calibrated to give the same results for the same samples as and when they are tested with cable and lug connections in accordance with **8.0**.

8.23.2 The voltage drop across the terminals of each circuit-breaker shall be measured at 100 percent normal rated current and shall not exceed the limits specified in **8.16.4**.

8.23.3 Each circuit-breaker shall be tested at 200 percent normal rated current at normal ambient temperature to show that at 27°C, it will trip within the time limits stated in Table 1. Within 20 s of tripping, the circuit-breaker shall reclose without current flow and shall latch-in (that is the automatic tripping device shall have re-set within 20 s. This test shall be performed twice.

8.23.4 After the test described in **8.23.3** the circuit-breaker shall be closed on 200 percent normal rated current and with the operating device held in the closed position, shall trip automatically. On release, the manual operating device shall return in the correct manner to the open position. After this test the circuit-breaker shall be reclosed manually.

8.23.5 Each circuit-breaker shall carry 115 percent normal rated current for 2 h without tripping.

8.23.6 The test described in **8.23.3** shall then be repeated at currents of 150 percent, 200 percent and 300 percent normal rated current.

APPENDIX A

(*Clause* 8.2.1)

SELECTION OF SAMPLES

A-1. A total of ten circuit-breakers, or 0·1 percent of the batch, whichever is greater, which shall be representative of all ratings in the batch, shall be taken at random from each batch of circuit-breakers. The system for batching production shall be agreed between the manufacturer and the purchaser or Inspecting Authority, as appropriate, and declared. The selection of samples shall be made from circuit-breakers which have previously been subjected to the routine tests and which have passed these tests. For the following tests, connections to circuit-breakers shall be by cables and terminations as required by **8.0**. In the event of any failure in the course of these tests the batch shall be deemed not to comply with this standard.

INDIAN STANDARDS ON AIRCRAFT ELECTRICAL EQUIPMENT

IS:

2032 (Part XV)-1976	Graphical symbols used in electrotechnology: Part XV Aircraft electrical symbols
7854-1975	Voltages and frequency for aircraft electrical systems
7855-1975	Form of declaration of performance of aircraft electrical equipment
7856-1975	Safety features for ground power units for direct current aircraft servicing and engine starting
7857-1975	Aircraft-fuel nozzle grounding plugs and sockets
7915-1976	Dimensions for connections for aircraft ground electrical supplies
8252 (Part XVIII)-1978	Environmental tests for aircraft equipment: Part XVIII Magnetic influence
8705-1978	Static invertors for aircraft
8706-1978	Safety features for ground power units for alternating current aircraft servicing
8834-1978	Dimensions for general purpose push-pull three-pole circuit-breakers for aircraft
8852-1978	Dimensions for general purpose push-pull single-pole circuit-breakers for aircraft
8946-1978	General requirements for rotating electrical machinery for aircraft